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Pink Bollworms: A 5-year Study of Cultural Control in Southern Arizona

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ABSTRACT

Winter survival of pink bollworm, *Pectinophora gossypiella* (Saunders), was low when cotton was picked early, the crop residues shredded, and the land plowed promptly. Highest mortality occurred when the cotton land was subsequently planted to small grain or cotton. Fallow land without a seal of the soil surface was the biggest reservoir of pink bollworms. The seal may be introduced by heavy rainfall or thorough irrigation. Moths emerging in the early spring dispersed widely, but when fruiting of cotton commenced the emerging moths settled in the nearest available fruiting plants.

KEYWORDS: Pink bollworm, cultural control of pink bollworms, sex lures.

CONTENTS

	Page
Introduction.....	1
Methods and materials.....	2
Results and discussion.....	3
Literature cited.....	9

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PINK BOLLWORMS: A 5-YEAR STUDY OF CULTURAL CONTROL IN SOUTHERN ARIZONA

By R. E. FYE¹

INTRODUCTION

Two major problems in the assessment of pink bollworm, *Pectinophora gossypiella* (Saunders), populations are the determination of the numbers surviving the winter and the distance that the individual adult moths move after they emerge from hibernation. Many experiments have been directed toward the study of the effects of cultural practices on hibernating pink bollworms (for example, Noble (9),² Watson and Larsen (13)), and the results have been variable. Less is known about the movement of pink bollworm moths after emergence in the spring. The following study was made from the fall of 1971 through the spring of 1976 to determine the effects of winter tillage, irrigation, and rainfall on the winter survival. The distance that hibernating pink bollworms move after spring emergence was studied in the spring of 1972.

METHODS AND MATERIALS

In 1972, Hexalure traps of the type described by Bryan et al. (1) were placed in sets of four approximately 25 ft apart in various locations (fig. 1) over the study site utilized for the introduction of the parasites *Bracon kirkpatricki* (Wilkinson) and *Chelonus blackburni* (Cameron) in 1971. The catches in the trap were checked at weekly intervals from the time the cotton emerged from the ground until the cotton was defoliated. Similar trap placements were made in 1973, 1974, 1975, and 1976, and the trap collection were also checked at weekly intervals.

Counts of the number of blooms on 650 ft of row were made weekly during the peak blooming period each season. At the same time, the number of blooms

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²Italic numbers in parentheses refer to Literature Cited, p. 9.

Mean Weekly Sex-Lure Trap Catches
May 23-July 18, 1972

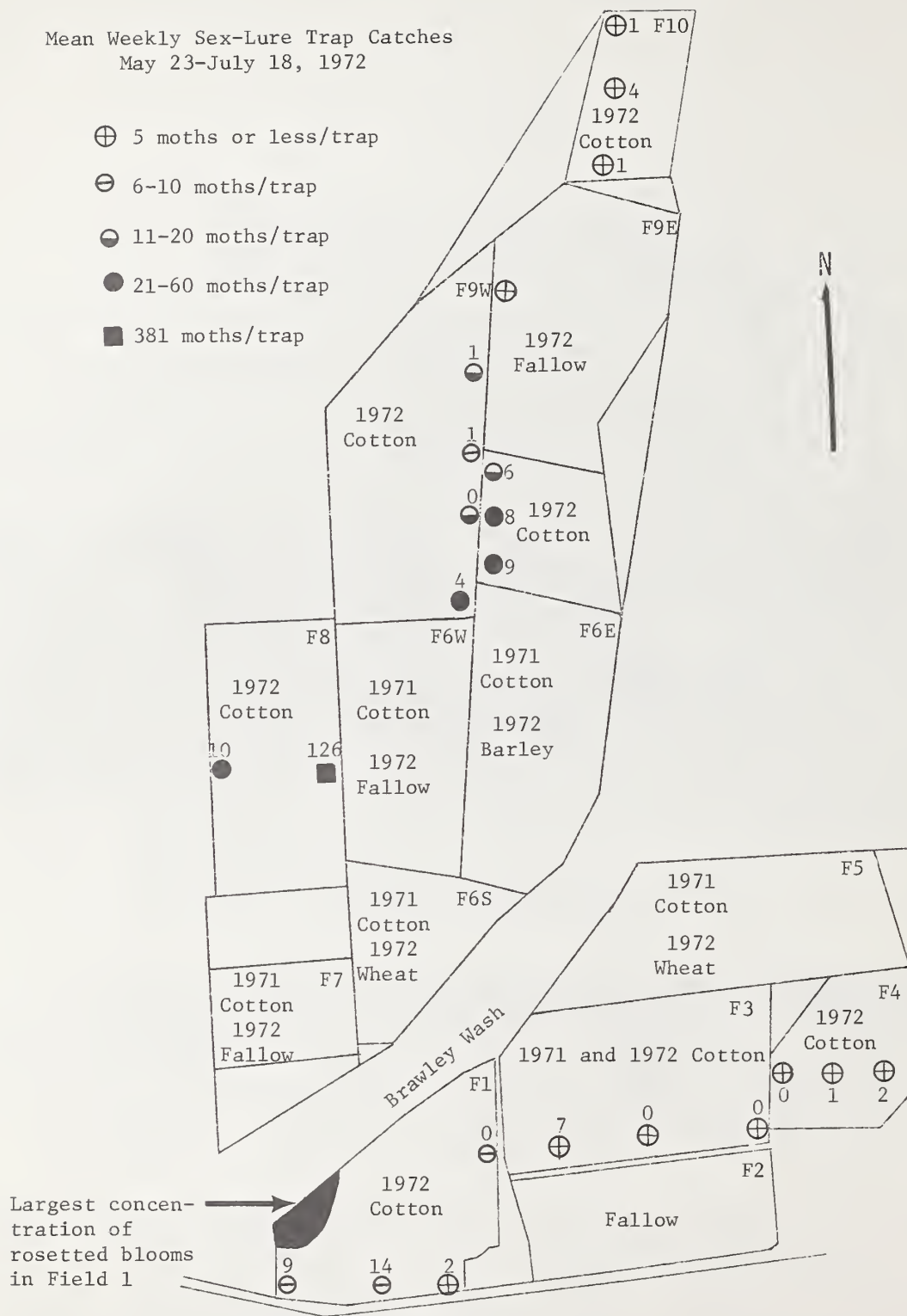


Figure 1.--Sex lure trap catches and the number of rosettes per 1,000 blooms (Arabic numbers adjacent to trap catches) for four dates. Buckelew Ranch, Robles Junction, Ariz., 1972.

rosetted by the first generation of pink bollworm larvae was noted. The bloom counts were made in the immediate vicinity of the traps. Similar counts were made on 1,300 ft of row in 1973, 1974, 1975, and 1976.

During the fruiting season from 1971 to 1976, 160 bolls as four replicates of 40 bolls were gathered weekly from each field planted to cotton and held in the insectary for 21 days in hardware cloth trays in ventilated sweater boxes (6). At the end of the 3-week period, the material was examined and the numbers of pink bollworm were noted. Similar samples were made in four fields at Midvale Farms near Tucson in 1974 and in a 10-acre block of experimental cotton at Marana, in Ariz., 1972, 1973, and 1974.

Immediately prior to each picking of cotton in each of the 6 years, estimates of the losses due to pink bollworm were made in each of the study fields. Bolls were counted on 100 randomly selected plants, and the numbers of locules damaged by pink bollworms and bollrot were recorded.

RESULTS AND DISCUSSION

The lack of adequate cultural control practices in the falls and winters of 1970 and 1971 is confirmed by the moth trap catches (table 1), the number of first generation pink bollworm larvae in 1,000 blooms (table 2), the larvae infestation in bolls (table 3), and the numbers of insecticide applications necessary for the control of pink bollworms (table 4); however, some evidence of the effects of proper cultural control practices were apparent in 1972. Although fields F5 and F6 (fig. 1) had relatively heavy infestation of pink bollworms in 1971, few moths were captured in the vicinity of these fields in 1972. Apparently, the plowing in the fall of 1971 preparatory for the planting of winter grain over the cottonfields and the sealing by the subsequent irrigations minimized the survival of the pink bollworms in these fields. The large captures adjacent to field F9E (fig. 1) probably originated in fallow field F6W and not F6E that was planted to barley. In field F3, which was planted in cotton in both 1971 and 1972, the captures of moths were also relatively low although the 1971 infestation of pink bollworms was high. This probably may be attributed to the thorough tillage, including plowing and bedding followed by thorough sub-irrigation for the 1972 crop. Thus, intense tillage and sealing by subsequent irrigations apparently caused high mortality among diapausing pink bollworms in fields planted to wheat and cotton in 1972.

The heavy survival of the pink bollworms in 1972 in fields F6W and F7 (fig. 1) probably may be attributed to the hard clods that resulted from plowing under extra wet conditions after heavy rains in November and December of 1971. Inspection showed that the hard clods provided many wide interstitial spaces from the bottom of the plowed layer to the surface and apparently allowed the egress of surviving moths from the lower levels of the plowed layer. The situation was complicated by the lack of rainfall (table 2) between the plowing date and the period of emergence of pink bollworm moths. Normally, seasonal rains occur in the southwest in January and February, and the surface of the plowed soil is generally sealed; however, the lack of rainfall from the end of December 1971 to late May 1972 (table 2) resulted in poor surface seal in the fallow field. Therefore, the surviving moths probably had ready egress to the surface.

Table 1.--*Hexalure trap catches of pink bollworm moths*

Moths per trap per week

Week of	Robles Junction						Marana			Tucson
	1971	1972	1973	1974	1975	1976	1972	1973	1974	1974
Apr. 1	0	0.08	0	0	0	0	---	---	---	0
8	.04	.03	0	0	0	.04	---	---	---	0
15	0	0	0	0	0	0	---	---	---	0
22	0	0	0	0	0	.02	---	---	---	0
29	0	0	0	0	0	0	---	---	---	0
May 6	0	.02	0	.02	0	0	---	---	---	.04
13	0	.02	.03	0	0	0	---	---	0	.07
20	0	.10	.18	0	0	.05	---	0.19	.13	.11
27	.05	.10	.01	.02	.07	0	---	.06	.25	.04
June 3	.10	1.17	.21	.02	0	.16	---	.44	.25	.08
10	.05	.99	.13	.04	.28	.13	---	2.06	.25	.04
17	.86	3.47	.33	.16	.84	.21	---	2.25	2.00	6.19
24	.16	3.59	.11	.08	.53	.30	---	2.31	.19	.89
July 1	3.03	15.05	.11	.02	.53	.21	---	1.38	.38	1.00
8	2.69	.93	.04	.04	.03	.06	---	2.63	.19	.19
15	1.48	2.49	.11	.06	0	.25	---	.13	0	2.14
22	3.35	2.84	.24	.07	.03	.16	---	.88	0	.71
29	1.86	.73	.40	.27	.03	.13	---	.57	.06	.82
Aug. 5	.47	.77	.03	.13	.08	.23	---	.38	.19	.44
12	.30	1.15	.65	.88	.08	.89	0.81	1.31	.25	4.07
19	1.18	2.84	.09	.66	.50	.88	.06	.88	.44	7.37
26	4.40	11.38	.67	4.24	.21	3.75	2.00	1.75	3.86	6.46
Sept. 2	5.33	3.02	.78	6.19	.21	1.56	1.07	6.69	6.09	1.81
9	4.85	2.86	.18	20.58	.68	4.55	1.69	15.25	4.56	35.40
16	1.13	.50	1.00	.28	1.08	2.70	1.87	29.62	9.23	10.61
23	1.18	3.16	.13	1.55	2.00	7.30	(¹)	17.00	(¹)	(¹)
30	3.43	1.64	.50	.31	4.15	2.52		5.51		

¹End of study.

Table 2.--Interpretive information for cultural control studies

Year	Acres of fallow after cotton	Inches of Rainfall		Pink bollworms per 1,000 blooms			Percent of damaged locules by pink bollworms			
		Dec.-Feb.	Mar.-May	Max.	Min.	Mean	Robles Junction picking		Marana picking	
							1st	2d	1st	2d
1971	0	0.97	0.25	7.6	1.0	2.2	6.2	---	---	---
1972	92	1.53	.42	11.7	1.9	4.6	7.7	10.7	8.6	---
1973	0	1.52	2.45	1.6	.9	1.0	2.8	4.2	2.1	---
1974	15	1.15	.65	0	0	0	.2	.9	2.1	20.4
1975	0	.35	1.05	1.5	.4	.6	8.0	19.0	---	41.8
1976	0	1.55	1.20	1.9	0	.1	1.8	10.1	---	---

Irrigated.¹

Table 3.--Pink bollworm infestations

Week of	Pink bollworms per 1,000 vulnerable bolls									
	Robles Junction					Marana				
	1971	1972	1973	1974	1975	1976	1972	1973	1974	Tucson 1974
July 1	---	---	---	---	---	---	---	---	---	---
8	0	5	---	0	---	---	---	---	3	---
15	23	21	3	1	---	---	---	36	---	55
22	43	21	9	2	0	1	---	44	25	32
29	60	62	40	14	8	10	9	80	53	91
Aug. 5	20	57	27	8	5	8	100	40	81	214
12	48	30	60	19	72	36	153	96	57	365
19	138	55	30	28	75	24	182	144	100	477
26	135	825	63	109	91	31	501	125	103	398
Sept. 2	1095	---	157	---	100	59	oli	160	---	669
9	743	---	271	---	197	75	1682	137	---	884

In the fall of 1972, the author suggested that the grower intensify, as far as practical, the cultural control practices generally recommended for pink bollworm control. These include the earliest possible picking of the crop followed by immediate residue destruction and plowing as quickly as possible. These fall practices were followed by thorough winter irrigation either for a winter grain crop or a subsequent cotton crop and irrigation of fallowed land if winter rains failed to seal the soil surfaces properly. The apparent success of the program in the subsequent 4 years is evident in the moth trap catches (table 1), the larval infestation of blooms (table 2), the larval pink bollworm infestation in bolls (table 3), and the minimal use of pesticides for the control of the pink bollworm (table 4). The differences in the weekly trap catches from June 3 to September 9 are significant ($p < 0.001$) as determined by the Friedman two-way analysis of variance by ranks (11).

The insecticides used for the control of lygus bugs and bollworms (table 4) are also partially successful in the control of pink bollworms. Generally, the applications of pesticides must be considered as potentially controlling the pink bollworms moths present; however, several of the applications applied for other pest insects were put on at a time during relatively low flight of bollworm moths

Table 4.--*Insecticide applications in cultural control study area, 1971-76*

Date	Proportion of fields ¹	Target insect
<i>1971</i>		
July 23	3 of 6	Pink bollworms.
27	2 of 6	Lygus bugs.
30	3 of 6	Pink bollworms.
Aug. 6	3 of 6	Do.
21	4 of 6	Bollworms.
Sept. 5	4 of 6	Pink bollworms.
<i>1972</i>		
June 21	3 of 7	Lygus bugs.
July 4	1 of 7	Do.
12	1 of 7	Pink bollworms.
18	1 of 7	Do.
Aug. 3	7 of 7	Lygus bugs, bollworms.
24	3 of 7	Pink bollworms.
<i>1973</i>		
Aug. 10	8 of 8	Stink bugs.
Sept. 2	8 of 8	Pink bollworms.
8	8 of 8	Do.
14	5 of 8	Do.
<i>1975</i>		
Aug. 17	4 of 4	Lygus bugs.
<i>1976</i>		
Aug. 18	3 of 7	Lygus bugs, bollworms.

¹No application in 1974.

(tables 1 and 4), and their impact on the pink bollworm population probably was not as great as it might have been if applied during major flight periods.

Examination of the damage data in table 2 indicates that during the heavy insecticide application years of 1971 and 1972 the damage was nearly as great as in the year of 1975 when a single application of insecticide was applied for lygus bugs on August 17 (table 4). This application of insecticide was made at a time when the moth flight had increased (table 1) and apparently exercised some control over the adult moths; however, it failed to curtail the boll infestation of larvae that resulted from a relatively late crop residue destruction in the fall of 1974 (table 3), and the surviving pink bollworm moths and their descendants had a negative impact on the late maturing crop of 1975. The damaged locule data in table 2 may be considered an appreciable overestimate due to the fact that many locules, particularly those maturing early and picked at the time of the first picking, are not totally destroyed.

The data from the Marana experimental and Midvale farms near Tucson are included for comparison with uncontrolled conditions. The heavy infestations at Marana in 1972 (tables 1 and 3) demonstrate the damage (table 2) of relatively high levels of infestation. Although potentially high overwintering populations existed in the fall of 1972, the heavy rainfall in the spring of 1973 (table 2) apparently sealed the emerging moths in the ground and resulted in a relatively low infestation in 1973. Although small numbers overwintered, a major damaging population failed to develop. The 1974 data from Tucson (table 1, 2, and 3) demonstrate poor cultural controls in the vicinity of the study fields as well as a lack of a soil seal by winter and spring rains. A heavily infested field from 1973 was fallowed in 1974 and not irrigated. Spring rains were apparently inadequate (table 2) to create a proper soil seal on the surface. In addition, neighboring growers failed to provide cultural control and did not destroy their previous season crop residues until nearly time for spring tillage for the 1974 crop, thus providing a large flight of pink bollworms early in the season. The general failure of introduced parasites under such pressures has been noted previously (1).

The planting pattern at Robles Junction in 1972 (fig. 1) afforded an opportunity to analyze the spring movement of moths surviving in the winter. Between March 21 and May 23, small numbers of pink bollworm moths were captured (table 1) in traps scattered over the entire ranch. The moths were caught in traps in all fields from F1 and F3 on the south to F10 on the north, and from field F8 on the west to F4 on the east. During this period, the cotton was not fruiting and the pink bollworms apparently moved without regard to the presence or absence of cotton. When the cotton began fruiting on about May 23, a definite pattern emerged. The largest number of pink bollworm moths were captured in fields F8 and F9E and the southern portion of field F9W adjacent to 1971 cottonfields (F7 and F6W) that had high infestations and were fallowed in 1972 (fig. 1). The next highest levels of capture in the Hexalure traps occurred in the western sector of field F1, which is a short distance from the fallow F7 that had large numbers of pink bollworms present in 1971. The spring flight on the Tucson ranch in 1974 resembled the flight observed at Robles Junction in 1972.

The data from Robles Junction show an interesting trend. High populations of pink bollworms went into hibernation in the fall of 1971 and large numbers survived the winter. The winter was exceedingly dry after December 1971 and met

the criteria for high survival discussed by Chapman et al. (3). In addition, the heavy rains in early December created an excessively wet condition, and the plowing in late December resulted in large clods. Thus, large interstitial spaces existed in the plowed layer through which the emerging pink bollworms apparently could escape, and the lack of rainfall resulted in the surface remaining unsealed (5). Therefore, the 1971 cottonfields fallowed in 1972 provided a large reservoir of moths to initiate the 1972 pink bollworm population.

In the subsequent falls, the crop was harvested early, the stalks destroyed, and the cottonfields plowed by late October. The early plow-down dates resulted in high mortality (15). Heavy rainfall in several of the winters and springs (table 2) sealed the surface of all the fallowed fields. Other portions of cotton land were plowed and planted to small grains that were irrigated when necessary throughout the entire winter and late spring, thus reducing the pink bollworm survival. Cotton land to be planted in cotton the subsequent year was bedded in February and the pre-irrigation applied, thus meeting the high mortality criteria presented by Fife et al. (4). Therefore, all the land on the ranch was sealed by moisture, and the emergence of pink bollworms was generally low. The low overwintering populations resulted in lower summer populations and reduced applications of insecticides (table 4).

The data indicate that normal farming practices employed in the Tucson area will generally control pink bollworms if proper crop residue destruction and deep plowing are employed. These practices would generally control early emerging pink bollworms (10) on land cropped in the winter or in the subsequent year but would not effectively control pink bollworms if the land was fallowed. The emergence from fallowed land apparently is dependent upon natural rainfall, and in dry springs the insects are not triggered from diapause by moisture as suggested by Watson et al. (14) and Slosser and Watson (12) but emerge over a long period as demonstrated by Fye (7). In years with heavy late winter and spring rains, the fallowed fields would normally be sealed with a tight layer of soil, thus partially preventing the emergence of pink bollworm moths. The seal may also be created by bedding and irrigating any portion of the fallow land. The success of the sealing layer has been noted by Watson and Larsen (13) who found that a cultipack layer on the surface of deeply plowed land was a more effective control of pink bollworms than was plowing alone. The necessity of plowing was noted in earlier studies (4, 14) and confirmed by the studies of Mueller et al. (8) in California who found that large numbers of pink bollworm moths would emerge after winter cropping with sorghum or small grains if deep desking was the only basic tillage.

The data presented above confirm the observations of earlier workers that early harvest, crop residue destruction, and plowing followed by a soil sealing by some mechanical process, irrigation, or natural rainfall will effectively reduce populations of overwintering pink bollworms. If the reduction is great enough, populations of pink bollworms in the subsequent year will require minimal numbers of insecticide applications for their control.

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